1.0 INTRODUCTION

This report, *The Initial Surface Water Quality Watershed Characterization and Assessment Report for the Rancocas Creek Watershed Management Area (WMA #19)*, represents an initial step in the watershed management planning process that summarizes existing information related to surface water quality in WMA #19 that was readily available to the Department. This report serves two main purposes: 1) it is a preliminary step towards developing a comprehensive watershed characterization and assessment report for the WMA #19; and 2) it compiles preliminary information to help define a set of surface water quality issues including the development of Total Maximum Daily Loads (TMDLs) for the impaired waters within WMA #19.

This Surface Water Quality Characterization Report relies on information readily available to the Department and was gathered from published reports, ambient and site-specific monitoring data, and our geographic information system (GIS). Regulatory and other program reports and databases were used to generate maps and summarize "contributing factors" information. Subsequent to this report, emphasis will be placed on identifying and integrating other data sets (including stakeholder data) through the ongoing watershed management planning process. It is expected that additional information will be required to complete the analysis, including monitoring, modeling, and a more refined assessment of potential contaminant loads. The report makes extensive use of GIS maps in conveying surface water quality characterization data (e.g. point and nonpoint sources of pollution, known contaminated sites, roads, population, and pesticide applications) as deemed appropriate.

This Surface Water Quality Characterization Report will supply the water quality component of a much broader assessment to be summarized in a subsequent Watershed Characterization and Assessment Report for WMA #19. The expanded Watershed Characterization and Assessment Report will include new and additional data, findings and other contributions from the Department and the WMA #19 stakeholders, and will address other watershed issues such as water quantity, land and biotic resources, contributing factors, existing and planned management measures, and data management/data assessment needs. Once the expanded report is complete, it will still be viewed as a "living document" and will be expected to change over time based on continued input from WMA #19 stakeholders. Such changes will serve as part of the iterative planning cycle. In the future, an INTERNET version of this and other related documents will be made available to the general public as a Watershed Webpage.

1.1 BACKGROUND

New Jersey's watershed management approach relies on sound science and a collaborative stakeholder process to protect, maintain and improve the water resources of the state. In order to achieve this goal, the New Jersey Department of Environmental Protection (Department) intends to employ a collaborative planning process by which government agencies and the watershed community can work together to identify and address water resource issues and concerns on a geographic basis. The development of a watershed

characterization and assessment report is one of the first steps in this collaborative planning process. Watershed characterization and assessment will enable the Department and the stakeholders to target and prioritize watershed issues to be addressed through the watershed management process. Data gaps identified during this phase may require new monitoring and modeling efforts to both verify current water resource trends; to project future trends; and to identify water resource issues, problems and pollution sources.

The resulting detailed watershed characterization and assessment will identify a set of priority issues of concern for each watershed management area (WMA), to be addressed by the watershed management area plan (WMAP). To facilitate efficient compilation of characterization and assessment information and to mange resources in the planing process DEP has partitioned the State into twenty WMAs (See Figure 1.1-1). Specific water resource goals and measurable environmental objectives (e.g. 20% reduction in phosphorous loading, or elimination of projected water supply deficits, over a specified time period) will be developed for each issue. In certain watershed management areas, watershed goals will be formalized through the development of Total Maximum Daily Loads (TMDLs). TMDLs represent the assimilative or carrying capacity of the receiving water, taking into consideration point and nonpoint sources of pollution, as well as surface water withdrawals and ground water and atmospheric deposition impacts on receiving waters. TMDLs are an important planning tool, since they can be used to explore different load allocation strategies and to reserve future capacity of receiving water in order to meet certain watershed protection goals.

Where TMDLs are required to address documented surface water quality impairment; a TMDL is developed as a mechanism for identifying all the contributors to surface water quality impacts and for setting goals for load reductions for specific pollutants as necessary to meet surface water quality standards. Allocations are made to the varying sources contributing to the water quality problem in order to reduce the total pollutant load received by the waterbody. Load reduction goals established through TMDLs are achieved through the issuance of wasteload allocations (WLAs) for points source discharges, load allocations (LAs) for nonpoint source discharges, and water allocations for surface water withdrawals.

In some watershed management areas, TMDLs may still be required even though the receiving waters are predominantly impacted by nonpoint source pollution. In such cases, the TMDL would consist mainly of the load allocation for the major categories of nonpoint source pollution contributors along with an implementation plan for best management practices (BMPs) for stormwater management and nonpoint source pollution control, headwaters protection practices, or other mechanisms for addressing the priority issues of concern.

The Watershed Characterization and Assessment Report for WMA #19 will ultimately provide the scientific basis for establishing a planning baseline that will be used by the Department and the WMA #19 Public Advisory Committee to identify and prioritize issues of concern and to establish environmental goals and objectives for the watershed management area. It will serve as a technical support document for the watershed management area plan, which will identify regulatory and non-regulatory management measures, responsibilities and funding needed to attain the environmental goals and

objectives. The watershed management area plan will include: a summary of the baseline information; water resources trends and priority concerns; watershed goals and objectives; selected management strategies, including pollution trading agreements as appropriate; and implementation responsibilities and schedules.

Active involvement of watershed stakeholders is essential to the successful development of a comprehensive watershed management plan. A partnership is being formed in WMA #19 that includes representatives of federal, state, regional, and local agencies, academics, citizens, business and industry, water purveyors, dischargers, agriculturists, environmental and public interest groups. The Public Advisory Committee and subcommittees will provide a formal avenue for this partnership to work with the Department on expanding and refining this initial Surface Water Quality Characterization Report into a comprehensive Watershed Characterization and Assessment Report through the watershed management planning process.

In presenting this report, the Department recognizes that the preliminary data and findings presented here are incomplete and need to be expanded and refined through a collaborative stakeholder process. However, by compiling and evaluating the Department's own database for information and trends pertinent to the surface water quality issues in WMA #19, the Public Advisory Committee will have the information with which to begin implementing the watershed management approach presented in the *Draft Statewide Watershed Management Framework Document for the State of New Jersey* (January 1997).

2.0 SETTING

2.1 Location

Figure 2.1-1 depicts the 52 municipalities that lie entirely or partially within the WMA #19 boundary. It should be noted that at the edge of WMA #19 certain municipalities are in more than one WMA reflecting the integrative hydrologic approach to watershed management. The area, population and population density for each municipality is provided in Table 2.1-1 in Appendix 1. WMA #19 includes watersheds draining to the lower or middle portions of the Delaware River. The area overlies Burlington, Camden and Ocean Counties and includes the following watersheds:

Cooper River
Newton Creek
Pennsauken Creek
Mill Creek
Rancocas Creek
Pompeston Creek
Baldwin Run
McDonald's Branch

The Cooper, Rancocas, and Pennsauken watersheds are the principal drainages, which provide an important component to the Lower Delaware River Drainage Basin (See Figure 2.1-2). WMA #19 includes 465 square miles (6.0% of New Jersey) and at the widest points is approximately 41 miles long and 18 miles wide.

2.2 Surface Water Hydrology

WMA #19 lies in the Coastal Plain physiographic province. The western part is in the inner coastal plain and the eastern part is in the outer coastal plain. (See Figure 2.2-1). All of the WMA #19 streams and rivers generally flow westward and enter into the Lower Delaware River basin as tributaries. As such, they are all tidally influenced (at their mouths) usually to the first dam or impoundment above the confluence (Figure 2.2-2). Sandy soils and Pinelands vegetation dominate the eastern part of WMA #19 (i.e., the outer coastal plain) strongly influencing any hydrologic characteristics.

2.2.1 Cooper River

The Cooper River is 16 miles long and its watershed drains an area of 40 square miles. The river flows through Camden County to the Delaware River at Camden. The significant tributaries include the North Branch Cooper River and Tindale Run. Major impoundments include Cooper River Lake, Kirkwood Lake, Evans Pond, Linden Lake, Hopkins Lake, and Square Circle Lake. Tidal influences ends at the first impoundment in Camden City (i.e., Kaighn Avenue Bridge).

2.2.2 Pennsauken Creek

The Pennsauken Creek drains 33 square miles of southwestern Burlington County and northern Camden County. This creek flows into the Delaware River near Palmyra, New Jersey. The North Branch of the Pennsauken is in Burlington County, while the South Branch is the boundary between Burlington and Camden Counties. The tide affects the three-mile mainstem and the first few miles up the branches.

2.2.3 Rancocas Creek

The Rancocas Creek watershed is 360 square miles and the largest in south central New Jersey. Of this area, the North Branch drains 167 square miles and 144 square miles is drained by the South Branch. The North Branch is 31 miles long and is fed by the Greenwood Branch, McDonalds Branch, and Mount Misery Brook. The major tributaries to the South Branch include the Southwest Branch Rancocas Creek, Stop the Jade Run, Haynes Creek, and Friendship Creek. The mainstem flows about eight miles and drains an area of approximately 49 square miles before emptying into the Delaware River at Delanco and Riverside. Tidal influence occurs for about 15 stream miles, extending the entire length of the mainstream to the dam at Mt. Holly on the North Branch, Vincentown on the South Branch, and Kirby Mills on the Southwest Branch. Major impoundments include Medford Lake, Pine Lake, Browns Mills Lake, and Crystal Lake.

2.2.4 Other Drainages

Pompeston and Mill Creeks are minor drainages (relative to the hydrologic volume of the other waterways) in WMA #19, which feed directly into the Delaware River.

2.3 Land Use

Land use and land covers are shown on Figure 2.3-1. These digital land use data were generated from 1986 aerial photogrammetry. The primary land classifications in WMA #19 (as of that date) included: 44% forest, 30% built land, 17% agricultural, 5% wetlands, 3% water and 1% barren land. NJDEP has issued a contract to update land use and land cover data statewide using 1993/95 overflights. This work is expected to be completed in 2000.

2.3.1 Cooper River

There is intense development along the mainstem of the Cooper River and the areas adjacent to the North Branch. Overall land use in this watershed is primarily urban/suburban. Currently point source discharges are limited to a few minor industrial facilities (See Figure 4.1-1), a number of combined sewer outfalls or CSOs (See Figure 4.1-2) and stormwater outfalls.

2.3.2 Pennsauken Creek

Much of this watershed is developed as urban/suburban land with the remainder divided between farmland and forested land. Industry is concentrated at the mouth of the Pennsauken Creek. There are 10 NJPDES (surface water) permitted dischargers here, 2 industrial, 3 municipal and 5 petroleum cleanups.

2.3.3 Rancocas Creek

About half of this drainage basin is forested, with the remaining area divided between agricultural use and urban/suburban. Significant development is taking place in many former agricultural areas. The eastern part of this watershed drains the Pinelands Protection Area. There are 20 NJPDES permitted dischargers here, 13 are municipal, 4 industrial/commercial and 3 petroleum cleanup related.

2.4 Population

The population centers on the Cooper River are Camden, Pennsauken, Cherry Hill, Haddonfield, and Haddon Township. Populations in the Pennsauken Creek Watershed are centered in Mt. Laurel, Maple Shade, Cherry Hill and downstream of Maple Shade. Population centers in the Rancocas Creek Watershed are Pemberton Township, Medford Township, Medford Lakes Borough, Evesham Township, Mount Holly, and Willingboro.

Figure 2.4-1 contrasts municipal population densities (i.e., number of people per square acre) for 1980 and 1990. The density appears greatest in the western portion of WMA #19, near the mouths of the westward flowing rivers. Density then decreases as one progresses eastward (i.e., away from the Delaware Valley/Philadelphia Metropolitan area) into the more agricultural communities of the central region and the forested headwaters in the Pine Barrens. Based on this data, only two municipalities showed any increase in

population density between 1980 and 1990: Voorhees Township in the southwest and Wrightstown Borough in the northeast.

3.0 WATER RESOURCES CONCERNS

3.1 Surface Water Quality Monitoring

Monitoring data are used to establish baseline conditions, determine trends, and identify solutions to or further study water quality problems. The NJDEP's primary surface water quality monitoring unit is the Office of Water Monitoring Management, although monitoring functions are also performed by other units. The DEP and the United States Geological Survey (USGS) have cooperatively operated the Ambient Stream Monitoring Network (ASMN) in New Jersey since the 1970s. The data from this network have been used to assess the quality of freshwater streams and sediments. Although the network was sufficient to assess general status and trends, changes were needed to provide data for water quality indicators and watershed management. Therefore, a new network was designed by a DEP/USGS interagency committee which has been operating since the fall of 1997 (See Appendix 4).

Routine water column parameters and observations taken at each monitoring station include:

Water temperature	Flow-gage readings	weather conditions
Dissolved oxygen	pH	specific conductivity
BOD	Nitrite + nitrate	total phosphorus
TKN	Fecal coliform bacteria	enterococus bacteria
TOC		

Also collected are dissolved minerals (chloride, fluoride, calcium, magnesium, potassium, sodium, silica, and sulfate).

Supplemental water column parameters include:

Sulfide	total hardness	Beryllium	boron
Arsenic	Lead	Selenium	mercury
Cadmium	Chromium	Copper	iron
Manganese	Nickel	Zinc	aluminum
Phenol			

Supplemental sediment parameters include metals, organic pesticides, herbicides and PCBs.

The parameter list also includes the analysis of dissolved as well as total constituents: suspended solids, dissolved nitrate/nitrite, dissolved Kjeldahl nitrogen, dissolved phosphorus, biochemical oxygen demand (BOD), and chemical oxygen demand (COD) (the latter two at selected sites). These additions provide a detailed level of nutrient

assessment, allowing a better understanding of the cycling, transport, and fate of nutrients and organic carbon in state waters.

NJDEP Ambient Biomonitoring Network (AMNET): Ambient chemical monitoring is now extensively supplemented by biological assessments of in-stream benthic macroinvertebrate communities. These communities are examined using USEPA's Rapid Bioassessment Protocols. From this, evaluations regarding the overall health of instream biota are estimated and in so doing, are categorized as nonimpaired, moderately impaired and severely impaired. These biological assessments are useful in directly assessing the aquatic life support designated use, as well as revealing the impact of toxic contaminants, and detecting chronic water quality conditions which may be overlooked by the short-term "snapshot" view provided by ambient chemical sampling.

New Jersey Pinelands Surface Water Quality Monitoring Network: The Pinelands Commission and participating county health departments maintain a regional pinelands surface water quality monitoring and data management program. The objectives of the program are the collection, organization, and distribution of Pinelands surface water quality data (Parameters include: GET THIS FROM AL). Water quality monitoring is performed at 214 stream stations located within Ocean, Burlington, and Cape May Counties.

The National Hydrologic Benchmark Network: includes one monitoring station I New Jersey (i.e., McDonalds Branch of Rancocas Creek in WMA 19). National Hydrologic Benchmark Network monitoring stations are selected based on their remoteness from the activities and influence of people. Parameters and observations include: specific conductance, water temperature, stream flow, pH, DO, fecal coliforms, fecal strep, BOD, suspended sediment, sand-silt fraction, common ions, nutrients, dissolved solids, TOC, trace metals, and radiochemicals.

3.2 Surface Water Quality Standards

Water quality standards establish the water quality goals and policies underlying the management of the state's waters. These standards designate the use or uses to be made of the water and then set criteria and policies necessary to protect the uses, as well as the existing higher quality of many waters. In establishing water quality standards, the first step is to determine the water uses to be protected. The second step is to establish criteria based on sound scientific data to protect the designated uses. States are required to adopt water quality standards that will protect both the existing and designated uses of a waterbody with an adequate degree of safety. Modifications to the New Jersey Surface Water Quality Standards were proposed and formally adopted in 1993 (See Table 3.2-1). Among the most significant changes were numeric criteria for toxic and hazardous substances, a definition for wetlands which will act as an initial step toward developing Surface Water Quality Standards for wetlands, and modifications to stream classifications based upon newly acquired information on trout streams.

3.3 Chemical and Pathogenic Evaluation of Surface Water Quality

For the purposes of this report surface water quality information (except where noted) has been culled from the *New Jersey State Water Quality Inventory Report* which is prepared every two years, pursuant to Section 305(b) of the federal Clean Water Act (P.L. 95-217). Much of this section is taken from the 1996 edition of this Inventory which focuses upon water quality assessments of the principal waters of the state using chemical/physical data collected between 1991 through 1995 inclusive. In addition to chemical assessments, biological assessments employing Macroinvertebrate communities are now reported for the entire state for the first time. This summary covers issues and programs as known up until the end of 1996. For additional Pinelands data see Windisch 1989, 1990 and 1991.

3.3.1 Cooper River (1 Monitoring Station)

Locations: Cooper River at Haddonfield
Dissolved Oxygen: Acceptable.
Temperature: Acceptable.
Nutrients: High levels of total phosphorus are observed. Median total phosphorus is 0.23 mg/l and 100% of values exceeded the criterion of 0.05 mg/l applied to locations upstream of impoundments. Inorganic nitrogen (NO_2 + NO_3) is at acceptable levels; the median is 0.45 mg/l with no values exceeding 0.55 mg/l. Some samples are high with oxygen-demanding material; BOD levels were on occasion above 3.0 mg/l and the median was 2.1 mg/l.
Bacteria: Elevated. The geometric mean is 904 MPN/100 ml and 67% of samples exceeded the 400 MPN/100ml criterion.
Heavy Metals: All five-lead samples collected during the period of review exceeded the chronic aquatic life criterion. In addition, arsenic was observed at 2 to 3 ug/l in all five samples, which can cause concern for drinking water use.

Summary: This location is characterized by elevated total phosphorus, poor sanitary quality, and levels of arsenic and lead which could impair the water here for potable use and for aquatic life support, respectively. In spite of what is observed during this review period, water quality here has shown significant improvement over the prior review period (1986 through 1990). Significant reductions in nitrogenous compounds and fecal coliform bacteria are observed. Reductions are also noted in levels of total phosphorus.

3.3.2 Pennsauken Creek (2 Monitoring Stations)

3.3.2.1 Location: South Branch Pennsauken Creek - Cherry Hill

Dissolved Oxygen: *No* violations of the lower criterion for non-trout waters are observed; however, daytime dissolved oxygen levels are frequently low and suggest that night-time conditions may be unacceptable.
Temperature: Acceptable.

Nutrients: Highly enriched. Inorganic nitrogen is very high, with a median value of 2.8 mg/l. Total phosphorous is also very high, with all samples exceeding the 0.1 mg/l criterion. The median value is 0.34 mg/l.
Bacteria: Sanitary quality is very poor; the geometric mean is 3567 MPN/100 ml and 95% of samples exceeded 400 MPN/100 ml.
Heavy Metals: One of five arsenic samples was recorded at 2 ug/l, which suggests that additional sampling may be warranted to determine if arsenic should be of concern if the waters are used for drinking.
Sodium: One violation of the criterion was recorded; the median equaled 23.5 mg/l.
Other: Biochemical oxygen demand is high at this location where several samples exceeded 5.0 mg/l.

3.3.2.2 Location: North Branch Pennsauken Creek - Moorestown

Dissolved Oxygen: Acceptable.
Temperature: One violation of the upper criterion for non-trout waters was observed, and in-stream temperatures tend to run warm at this location.
Nutrients: Inorganic nitrogen is acceptable; median value is 0.37 mg/l. Total phosphorous is, in contrast, elevated, with 85% of samples exceeding the 0.05 mg/l criterion applied to locations upstream of impoundments. The median value of total phosphorus is 0.15 mg/l.
Bacteria: Mildly elevated bacterial levels were recorded at Moorestown. The geometric mean was 222 MPN/100 ml and 35% of samples exceeded the 400 MPN/100ml criterion.
Heavy Metals: As observed in the South Branch, one of four arsenic samples was recorded at 2 ug/l, suggesting that additional sampling may be warranted to determine if arsenic should be of concern if the waters are used for drinking. One of the four lead records exceeded the chronic criterion for aquatic life support.
Sodium: Two violations of the criterion were recorded; the median is 15 mg/l.
Other: Biochemical oxygen demand is relatively high; several samples exceeded 4.0 mg/l, two exceeded 8.0 mg/l.

Summary: In the South Branch of the Pennsauken, sanitary quality is poor and nutrient levels are very high. When compared to the previous assessment period (data collected from 1986 through 1990), there appear to have been reductions in levels of inorganic nitrogen and total phosphorus, and a notable decline in BOD. Sanitary quality, however, is the same as that observed in the last assessment. In the North Branch, sanitary quality is fair. Nitrogen levels are acceptable while total phosphorus is elevated. BOD is elevated, although not to the degree observed in the South Branch. Spring and summer water temperatures may tend to be excessive. Water quality, as reflected in fecal coliform and nutrient levels, has notably improved here compared to the previous assessment (based upon data collected between 1986 through 1990).

Note: Previous Inventory Reports have discussed high levels of chlordane and PCBs in fish that have been taken from the Pennsauken Creek mainstem and from the South Branch from Strawbridge Lake downstream. These levels were, and are still, regarded as

posing a potential health hazard; as a result, recreational fishing continues to be banned in these waterways.

3.3.3 Rancocas Creek (3 Monitoring Stations)

3.3.3.1 Location: North Branch Rancocas Creek - Pemberton

Dissolved Oxygen: Acceptable.
Temperature: Acceptable.
Nutrients: When viewed as FW2-Nontrout waters, inorganic nitrogen and total phosphorous are both acceptable, with median values of 0.145 and 0.035 mg/l, respectively. From a Pinelands waters perspective, inorganic and organic nitrogen, and total phosphorous are all at levels characteristic of moderately disturbed Pinelands waters (Zampella, 1994).
Bacteria: Very mildly elevated bacterial levels were recorded at this location. The geometric mean was 22 MPN/100 ml and 10% of samples exceeded the 400/100ml criterion.
pH and Conductivity: The median pH and conductivity reflect moderately disturbed Pinelands waters (Zampella 1994).
Heavy Metals: Heavy metals violations were frequent in these acid waters. Three of five copper samples exceeded both the acute and chronic criteria. Of five lead samples, four exceeded both the chronic and acute criteria, while the fifth exceeded the chronic criterion. One violation of the acute and chronic criteria for zinc was recorded (out of five samples).

3.3.3.2 Location: South Branch Rancocas Creek - Vincentown

Dissolved Oxygen: Daytime levels all lie within the FW2-NT criterion; however, warm weather levels are relatively low, suggesting stressful conditions at night.
Temperature: Although in-stream temperatures do not exceed the criterion for FW2-NT waters, they nonetheless tend to run warm in the summer at this location.
Nutrients: When viewed as FW2-Nontrout waters, inorganic nitrogen is acceptable and total phosphorous is mildly elevated, with median values of 0.55 and 0.11 mg/l, respectively. From a Pinelands waters perspective: inorganic and organic nitrogen, and total phosphorous are all at levels characteristic of disturbed Pinelands waters (Zampella, 1994).
Bacteria: Sanitary quality is very good at this location. The geometric mean was 61 MPN/100 ml and only 5% of samples exceeded the 400 MPN/100ml criterion.
pH and Conductivity: The median pH and conductivity reflect conditions observed in disturbed Pinelands waters (Zampella 1994).
Heavy Metals: The low hardness recorded in these acid waters renders the metals criteria very restrictive. As a result, one of four copper samples exceeded the chronic criterion for aquatic life support. Additionally, of four lead samples, all exceeded the chronic criterion, again for aquatic life support.

3.3.3.3 Location: McDonalds Branch in Lebanon State Forest

Dissolved Oxygen: Very depressed, more than half the samples below 4 mg/l.
Temperature: Acceptable.
Nutrients: The median inorganic nitrogen (NO_2 + NO_3), organic nitrogen, and total phosphorus are all characteristic of undisturbed Pinelands waters (Zampella 1994) and are consistent with levels observed between 1975 and 1986 (Zampella 1994).
pH and Conductivity: The median pH was characteristic of undisturbed conditions (Zampella 1994). Specific conductance was at the lower end of moderately disturbed conditions (Zampella 1994).
Bacteria: Fecal coliform levels were very low, with a geometric mean calculated to be less than 2 MPN/100ml.
Heavy Metals: This monitoring site is part of the USGS Hydrologic Bench-Mark network, a program for determining natural or background conditions, and as such does not sample for copper, lead, zinc and chromium.

Summary: Pinelands Water. When viewed as PL (Pinelands) waters, the North and South Branches of the Rancocas represent conditions reflective of moderately disturbed and disturbed Pinelands waters, respectively. From the perspective of FW2-Nontrout waters, the North Branch represents good conditions with acceptable nutrient levels and relatively good sanitary quality. The problem here, as in other acid waters, lies in the severely restrictive heavy metals criteria calculated for these waters. As the result, the North branch appears to experience chronic exceedances of copper and lead, and occasional exceedances of zinc. Current nutrient and sanitary conditions are similar to those observed during the last assessment period using data collected between 1986 through 1990. As FW2-Nontrout waters, the South Branch Rancocas represents fair conditions. Although inorganic nitrogen is acceptable, total phosphorous is mildly elevated, and sanitary quality is very good. Warm weather dissolved oxygen levels are suspected to be depressed at night, creating stressful conditions for aquatic life. As with the North Branch, this acid water experiences exceedances of copper and lead. As in the North Branch, present nutrient and sanitary conditions are similar to those observed during the last assessment period. McDonalds Branch, a tributary of the North Branch Rancocas, is sampled in Lebanon State Forest in the heart of the Pinelands Area and represents unimpaired background physical and water quality characteristics indicative of the Pinelands Area. Dissolved oxygen saturation is low, due principally to the fact that groundwater is providing much of the base flow at this location, and that surface flow is often slack which in turn can slow aeration. The median pH, 4.2 SU, is typical of unimpacted Pinelands waters where nutrient inputs are very limited.

3.4 Biological Evaluation of Surface Water Quality

Biological evaluations of surface water quality in New Jersey, as discussed above, are based on assessment of benthic invertebrate populations as represented in NJDEP's Ambient Biological Monitoring Network (AMNET). Specific AMNET results for WMA #19 are discussed below and summarized in Figure 3.1-1 and Table 3.4-1.

3.4.1 Cooper River

All monitoring locations on the North and South Branches of the Cooper River indicate severely impaired biota.

3.4.2 Pennsauken Creek

Macroinvertebrate community assessments indicated that the entire length of the South Branch of the Pennsauken Creek is severely impaired. The North Branch is also severely impaired at its lower end near the confluence with the South Branch, and is moderately impaired along its remaining length.

3.4.3 Rancocas Creek

The lower portions of the North Branch Rancocas are assessed as moderately impaired as are most of the tributaries to the North Branch. The upper portion of the North Branch itself as well as Mt. Misery Brook is nonimpaired. A tributary to the mainstem, Mill Creek, was observed to be severely impaired. McDonalds Branch's assessment has alternated between moderately and severely impaired depending upon the date of the assessment. Most monitoring locations in the South Branch Rancocas watershed are assessed as moderately impaired. There are, however, some locations that were assessed as either nonimpaired or severely impaired.

3.4.4 Other Drainages

Just north of the Pennsauken watershed are Pompeston Creek and Swedes Run. Pompeston is assessed to be moderately impaired; Swedes Run is moderately impaired in Moorestown and severely impaired in Delran.

3.5 Contamination in Fish Tissue

Since 1985, an intergovernmental Committee has been involved with the oversight and review of a monitoring program of chemical contamination in selected species of fish collected from New Jersey waterways in which elevated levels of these toxic chemical contaminants have been found or might be suspected. Results of these investigations resulted in fish consumption advisories for certain waterways in WMA #12 based on multiple contaminants of concern: Pennsauken Creek (north and South Branches) including Strawbridge lake; Cooper river and Cooper River Lake due to the presence of elevated levels the pesticide chlordane. This advisory prohibits the consumption of all aquatic species from the specified waterways. A NJDEP study of Mercury in Freshwater Fish (NJDEP 1994) identified certain species of fish in some freshwater bodies with elevated levels of mercury. To provide guidance for consumers of New Jersey freshwater fish, DEP issued Mercury based consumption advisories for two species of fish statewide - largemouth bass and chain pickerel. In issuing advisories for mercury in fish, New Jersey joins 32 other states. These advisories suggest to the public to limit the consumption of specific species from the WMA #19 waterways, the same waterways that are already

under regulation to prohibit consumption due to chlordane contamination. Therefore, any mercury advisory that may be issued to the anglers of this area would be superseded by the more restrictive chlordane advisory.

3.6 Evaluation of Water Quality in Lakes

3.6.1 Cooper River

Major impoundments on the Cooper River are located at Cooper River Lake, Kirkwood Lake, Evans Pond, Linden Lake, Hopkins Lake, and Square Circle Lake.

3.6.2 Pennsauken Creek

Previous Inventory Reports have discussed high levels of chlordane and PCBs in fish that have been taken from Strawbridge Lake. These levels were, and are still, regarded as posing a potential health hazard; as a result, recreational fishing continues to be banned in these waterways.

3.6.3 Rancocas Creek

Major impoundments include Medford Lake, Pine Lake, Browns Mills Lake, and Crystal Lake.

3.6.4 Other Drainages

Sylvan Lake in the Mill Creek watershed (Burlington Twp.) is listed on the State 303(d) list (See Section 3.7) as being water quality impaired for sedimentation, phosphorous and bacteria. Sources are suspected to be stormwater however recent remedial actions diverted stormwater from the lake.

3.7 Impaired Water: 303d List

Section 303(d) of the Federal Clean Water Act requires states to identify waters that are not attaining water quality standards, despite the implementation of technology based effluent limits (NJDEP 1998). States must then identify those high priority waterbodies for which they anticipate establishing TMDLs (See Section 1.3) in the next two years (i.e., 303(d) List). Waterbodies listed either exhibit observed violations of surface water quality standards or are suspected of having such violations based upon observed use impairments (e.g., biological impairments). From this list, a TMDL will be developed for each pollutant of concern following the procedures for developing TMDLs in N.J.A.C. 7:15-7, adopted on May 5, 1997. If, following this procedure, a waterway is found not to be impaired or unlikely to be impaired for a specific parameter, it will be de-listed for that specific use impairment through the next subsequent List.

The 1998 303(d) List has been divided into three distinct parts: 1.) Waterways with Known Impairments; and 2.) Candidate Waters (Sub-Lists A and B). In Appendix 1 Tables 3.7-1 through 3.7-7 summarize the impaired waterways by watershed for WMA #19 as derived from the 1998 303(d) List.

3.7.1 Waterways with Known Water Quality Impairment (Sub-List 1)

Sub-List I waterways are presented in the tables in Appendix 1 and include:

- Waters whose listings are based on conventional pollutants (except for ammonia) and fecal coliform,
- Twenty-two lakes with confirmation of water quality problems through complete Phase 1 studies under the Clean Lakes Program,
- Waters with fish consumption advisories in place; and
- Assessments compiled through monitoring programs subject to modern QA/QC procedures.

This sub-list is considered to be the list of waters for which TMDLs are known or strongly expected to be needed based on current information (i.e., meaning that numerical or narrative criteria are exceeded or that a use is confirmed as being impaired, as required by Section 303(d)1 of the Clean Water Act). DEP will continue to perform monitoring related to these data categories, and may revise the 303(d) List if conditions change so that more or fewer waters are confirmed as water quality-limited.

3.7.2 Candidate Waters (Sub-List II)

Sub-List II waterways include waters with some evidence of water quality problems but lacking sufficient information to confirm those problems. Therefore, a critical "next step" for all waters on the candidate list is supplemental monitoring. The Department does not consider these candidate waters as being "confirmed" for TMDL development until the results of the additional monitoring have been assessed. Such monitoring will be performed before or in step with the TMDL development schedule, so that each TMDL project is based on sufficient information. Based on the results of such monitoring, some waters will be identified as "water quality-limited," and therefore moved to the "Known" list as described above, and be subject to a TMDL. Other waters will be confirmed as not being water quality-limited, and that result will not be included in a subsequent 303(d) List. This sub-list is further divided into two parts (A and B) based on the strength of evidence for water quality impairment.

3.7.2.1 Candidate Waters (Sub-List IIA): Known Water Quality Impairment

Sub-List IIA waterways are presented in the tables in Appendix 1 and include waters exhibiting severe biological impairment. Their inclusion is based on a high expectation that such waters will exhibit water quality impairment. (These waters will often have physical

and habitat impairment as well). This sub-list also includes waters where the nature of observed biological impairment strongly suggests the presence of toxic substances.

3.7.2.2 Candidate Waters (Sub-List IIB): Suspected Water Quality Impairment

Sub-List IIB waterways are also presented in the tables in Appendix 1 and include waters impaired by heavy metals and ammonia, as well as assessed public lakes (i.e., sources of impairment suspected) and waters exhibiting moderate biological impairment. These waters either lack extensive data or the available information is not a strong indicator of water quality impairment, but sufficient data or indicators exist that further analysis is warranted. Tables list lakes in WMA #12 assessed by the Clean Lakes Program as use impaired but the sources of pollution are not yet determined. Water quality data for many of these lakes are old, with assessments having been performed in the late 1970s and early 1980s. Other lakes in this listing are judged to be impaired based upon cursory surveys covering only a single year of data collection.

3.8 Surface Water Intake Locations

In comparison to the large number of ground water withdrawals there are only 2 permitted surface water intakes in WMA #19. One is located on the North Branch of the Rancocas Creek (i.e., USDOD, Fort Dix) and the other is on the Delaware River mainstem (i.e., New Jersey American Water Co.). It should be noted that the Delaware River mainstem forms the westernmost border of WMA #19. However, the Delaware River Basin Commission (DRBC) is calculating the Delaware River TMDLs (DRBC 1998) in support of the Delaware Estuary Program (DelEP). Therefore, the NJ American Water Company's location (and withdrawals) will not influence calculations associated with WMA #19 waterways as defined by this assessment.

4.0 CONTRIBUTING FACTORS

Numerous point and nonpoint sources of pollution contribute to surface water quality conditions and trends; these factors are collectively called "contributing factors". Point sources discharge from a pipe or a ditch and include regulated facilities. Nonpoint sources of pollution emanate from diffuse sources that are often dispersed and difficult to control. Nonpoint sources within WMA #19 may include stormwater and runoff from developed or disturbed lands; contaminated sites; improperly placed or malfunctioning septic systems; air deposition; landfill runoff and leachate. Physical, chemical and ecological processes can transport toxics, nutrients and pathogens to surface water, ground water, sediments and plants and animals.

4.1 Point Sources of Pollution

As of June 1998 there were 52 regulated point sources (i.e., existing NJPDES Permit) in WMA #19 that discharge treated wastewater to surface water (See Figure 4.1-1). Regulated point source discharges are further broken down into major and minor facility types (Table 4.1-1) including:

- 21 municipal wastewater permits: typically a combination of municipal and industrial wastewater;
- 18 industrial wastewater/industrial stormwater permits; and
- 13 petroleum clean-up permits.

These facilities are regulated by effluent limitations specific to the type of facility, the type of discharge, or if necessary as a means to protect site specific water quality. For example, all municipal treatment plants at a minimum are regulated for oxygen demanding substances, total suspended solids, pH, oil and grease and fecal coliform. Effluent flow is usually monitored.

Also presented in Figure 4.1-1 are the locations of the NJPDES permitted Solid Waste Landfills (SWL) in WMA #19. Table 4.1-2 supplies additional information including closure status, waste types received and ownership. There are 49 SWLs in WMA #19: most of them municipal (25), or sole source (12) as well as two (2) which have been designated Superfund sites (i.e., federally managed known contaminated sites).

4.1.1 Cooper River

The water quality problems of the Cooper River had been attributed to excessive municipal and industrial wastewater discharges, combined with the effects of urban stormwater runoff, combined sewer overflows and the limited assimilative capacity of the stream. The Camden County Municipal Utilities Authority (MUA) regional sewage system has eliminated all of the municipal discharges to the Cooper River. A total of thirty-nine individual sewage treatment plants that were discharging inadequately treated wastewater into the Cooper River, its tributaries, as well as neighboring watersheds, have now been taken off-line and the flow conveyed to the upgraded and expanded Camden Co. MUA facility located in Camden City. As a result, dissolved oxygen levels have increased significantly.

4.1.2 Pennsauken Creek

Currently no STPs discharge into the South Branch Pennsauken Creek. Several treatment plants in the North Branch Pennsauken are undergoing or have undergone upgrades. Both the Moorestown and Maple Shade plants have undergone upgrades, while the Woodstown STP upgrade is currently ongoing.

4.1.3 Rancocas Creek

The North and South Branches of Rancocas Creek suffer from low to moderate amounts of water pollution coming from both point and nonpoint sources. No facilities are reported to be under Department enforcement action as of the summer of 1996. In the

tidal Rancocas Creek mainstem, a water quality modeling study had found excessive nutrients, elevated algae production, and highly fluctuating diurnal dissolved oxygen concentrations. The study also concluded that the principal sources of oxygen demand were more from sediment loading than from point source inputs.

4.2 Point Source Compliance

Information on permitting and enforcement actions for permitted facilities are reported annually by NJDEP in the Clean Water Enforcement Act Report. Recent enforcement actions taken by DEP on the non-permitted dischargers are summarized in Table 4.2-1.

4.3 Nonpoint Sources of Pollution

Forested areas account for the majority of the landuse (44%) in WMA #19 (See Figure 4.3-1) primarily located in the eastern section (i.e., within the development-protected Pine Barrens region). Agriculture accounts for 17% of the land use in WMA #19, primarily in the central region, which can be associated with non-point sources of pollution (e.g., nutrients from fertilizers, toxics from pesticides). However, 30 % of WMA #19 includes "built lands" which are aggregated in the western section and comprises the second major landuse in the area. Built land includes urban, suburban, industrial and commercial uses. Land development contributes to nutrient and toxic contamination from municipal stormwater and runoff, septic systems and higher flows at municipal treatment plants. Stormwater and runoff also negatively affects stream hydrology and aquatic habitat through erosion, flooding, and loss of healthy stream bed and corridor structure and ecological communities. Additional ground and surface water supplies will be withdrawn from aquifers and surface waters. The amount and location of impervious surface coverage can be used to indicate potential water quality problems caused by patterns of land development. Pollution and reduced ground water recharge begin to occur when 10 to 30% of the land surface is covered by impervious surfaces (Arnold and Gibbons, 1996). Impervious surface cover assessments for all watersheds in New Jersey are currently being developed (Charles, et. Al., 1993). See karen for references.

4.3.1 Cooper River

The 16 mile long Cooper River is reported to receive nonpoint source pollution from roadways and housing construction as well as from croplands, storm sewers, combined sewer overflows, suburban surfaces, highway maintenance, various spills, mining, and landfills. In addition, sediments in the Cooper River were contaminated through historical industrial and urban activities. Sediments may be significant source of pollutants via resuspension or release of contaminants. These, combined with point sources, are cited as contributing to impaired water quality and occasional fish kills in the river.

4.3.2 Pennsauken Creek

The North Branch of the Pennsauken is receiving pollution from several nonpoint sources. These include runoff from urban surfaces, roadways, bridge and highway construction sites, and leachate from landfills. Additional suspected sources include construction activities (declining), storm sewers, an industrial tract in Palmyra (oil runoff), septic systems, mining, and agricultural sources. The New Jersey Division of Fish, Game, and Wildlife evaluates many of these sources as threatening the health of the fishery resources of the North Branch. Fish kills have occurred in Pennsauken Creek over the years.

Two lakes within the Pennsauken watershed have been reported as impaired by nonpoint sources. Strawbridge Lake receives urban runoff from a dense development of homes, offices, and light industry. This pollution is suspected as having contributed to fish and duck kills. Recently a lake rehabilitation project for the lake was performed that included draining and dredging. The other lake, Memorial, also receives urban surface runoff which causes excess siltation.

4.3.3 Rancocas Creek

Agricultural and suburban runoff is responsible for the pH, bacteria, and nutrient concentrations that are higher than natural background levels. It is expected that significant development pressures will further stress the streams in the Rancocas watershed. The Upper North Branch of the Rancocas receives nonpoint runoff from a wide assortment of sources; among these are dairy farms, croplands, road and housing construction, urban surfaces, and storm sewers. The New Jersey Division of Fish, Game, and Wildlife evaluates the fisheries in the lower reaches of the North Branch as being threatened by runoff from housing construction, road maintenance, croplands, and the subsurface infiltration of septic wastes. The landfill in Pemberton has been described by local authorities as a threat to local water quality.

The fish population of Cranberry Branch, a tributary to the North Branch, is threatened by subsurface infiltration of septic wastes. In addition, this stream is believed to receive nonpoint source pollution from cropland runoff and from local housing construction. The upper South Branch Rancocas is suspected of suffering water quality degradation from sod farm runoff, road and housing construction, urban surface runoff, and septic tank leachate. Furthermore, a landfill in Lumberton is suspected of affecting water quality there.

The lower South Branch receives much of the same nonpoint source pollution as the upper reaches including runoff from housing construction, urban surfaces, croplands, septic systems, and surface mining activities. These are all believed to be associated with past fish kills, which have occurred in this waterway.

Friendship Creek, Mason Creek and Mill Creek, all tributaries to the Rancocas, are suspected of being impacted by road and highway runoff. Friendship Creek is believed to be further impacted by a local sanitary landfill, while Mill Creek is suspected of being affected by urban runoff.

4.4 Known Contaminated Sites

There are 514 known contaminated sites identified in WMA #19 (See Figure 4.4.1-1). These sites are managed by different elements within DEP's Site Remediation Program (SRP) based on the type of site (e.g., underground storage tank, federal facility, etc.), and the funding source for cleanup (e.g., public vs. private). These sites have been also been classified into remedial groups based on their level of complexity (See Table 4.4-1). The 514 known contaminated sites in WMA #19 fall into the following classifications:

A: Emergency or single phase, short-term cleanup
B: Single phase cleanups of – only soils (41 sites);
C1: Single source/single contaminants affecting both soil and groundwater (126 sites);
C2: Multiple sources/contaminants affecting soil/groundwater - moderate (255 sites);
C3: Multiple sources/contaminants affecting soil/groundwater - severe (48 sites);
C4/D: Superfund –severe and complex (29 sites); and
NA: Known sites not adequately assessed to rank (11 sites).

This classification of site complexity into different levels is based on the SRP's 1989 Case Assignment Manual. The intent of the remedial level determinations are to reflect the overall degree of contamination at a site recognizing that individual areas of concern may involve remedial actions of varying levels which are explained below.

Level A: An emergency action taken to stabilize an environmental and/or health-threatening situation from sudden or accidental release of hazardous substances. Appropriate remedial actions involving a single phase of limited or short-term duration.
Level B: A single-phase remedial action in response to a single contaminant category effecting only soils. May be a sub-site of a more complex case. Does not include ground water investigation or remediation. Examples of level B cases include, but are not limited to "cut-n-scrape"; surface drum removals; fences; temporary capping or tarping.
Level C-1: A remedial action, which does not involve formal design where source is known/identified. May include the potential for (unconfirmed) ground water contamination. Examples of C-1 cases are regulated or unregulated storage tanks containing gas or heating oil; septic tanks etc.
Level C-2: A remedial action that consists of a formal engineering design phase, and is in response to a known source or release. Since the response is focused in scope and addresses a known, presumably quantifiable source, this remedial level is of relatively shorter duration than responses at sites with higher remedial levels. Usually involves cases where ground water contamination has been confirmed or is known to be present.
Level C-3: A multi-phase remedial action in response to an unknown and/or uncontrolled source or discharge to the soils and/or ground water. In this remedial level the contamination is unquantifiable (or presumed unquantifiable) and, therefore, no determinable timeframe for the conclusion of the remedial action is known.
Level C-4/D: A multi-phase remedial action in response to multiple, unknown and/or uncontrolled sources or releases affecting multiple medium which includes known

contamination of groundwater. In this remedial level the contamination is unquantifiable (or presumed unquantifiable) and, therefore, no determinable timeframe for the conclusion of the remedial action is known.
Level NA: Not Assessed.

4.5 Pesticide Usage

Pesticide use data are collected on a county basis and with screening of the reports for Burlington, Camden and Ocean counties further data analysis will be performed on a WMA basis. (PLACEHOLDER – i.e., data are being recompiled on WMA basis and will be provided later).

5.0 PRELIMINARY ASSESSMENT

5.1 Surface Water Classification Areas

5.1.1 Active Monitoring Stations

Station	Classification
No. Branch Rancocas Creek at Pemberton	FW-2 Nontrout/PL
So. Branch Rancocas Creek at Vincentown	FW-2 Nontrout/PL
McDonalds Br. in Lebanon State Forest	PL
So. Branch Pennsauken Creek at Cherry Hill	FW-2 Nontrout
No. Branch Pennsauken Creek near Moorestown	FW-2 Nontrout
Cooper River at Haddonfield	FW-2 Nontrout

Note: The North Branch Rancocas Creek at Pemberton and the South Branch Rancocas Creek at Vincentown both lie at the border of the Pinelands Commission's Protection Area, and hence are assessed as both FW-2 Nontrout waters and as Pinelands (PL) waters.

5.1.2 Discontinued Monitoring Stations (as of 1991)

Station	Classification
Cooper River at Lindenwold	FW-2 Nontrout
Cooper River at Lawnside	FW-2 Nontrout
So. Branch Rancocas Creek at Hainesport	FW-2 Nontrout
No. Branch Rancocas Creek at Browns Mills	FW-2 Nontrout
No. Branch Rancocas Creek at Mt. Holly	FW-2 Nontrout

5.2 Designated Use Assessments

5.2.1 Swimmable Support Status

Swimmable support status is based on fecal coliform concentrations in streams. Local health officials assess bathing beaches at lakes and data have not been reported to NJDEP, precluding an analysis of swimmability at these beaches.

WATERWAY	LOCATION	STATUS
No. Br. Rancocas Ck.	At Pemberton	Full Support
So. Br. Rancocas Ck	At Vincentown	Full Support
McDonalds Br.	Lebanon State Forest	Full Support
So. Br. Pennsauken Ck	At Cherry Hill	No Support
No. Br. Pennsauken Ck	Near Moorestown	No Support
Cooper River	At Haddonfield	No Support

5.2.2 Aquatic Life Designated Use Status

Aquatic life designated use status is based on benthic macroinvertebrate monitoring data. Based on data collected through 1995, published in the 1996 Statewide Water Quality Inventory Report, 9 stations out of 39 (23%) in WMA #19 showed no impairment, 22 (56%) showed moderate impairment, and 8 (21%) showed severe impairment. Additional benthic macroinvertebrate data have been collected, and these will be incorporated into future assessments of water quality in WMA #19. Note: See Biological Assessment Table 3.4-1 (Appendix 1) for details regarding macroinvertebrate assessments within sub-watersheds within WMA #19.

5.3 Designated Use Assessment by Sub-Watershed

5.3.1 Cooper River

The Cooper River at Haddonfield does not support the Swimmable (primary contact) designated use. The "aquatic life" designated use is not supported in either the Cooper River or the Newton Creek watersheds based upon macroinvertebrate monitoring.

5.3.2 Pennsauken Creek

Limited support of designated uses occurs in the Pennsauken watershed. Primary contact recreation is precluded in the waterways due to excess fecal coliform bacteria levels. The "aquatic life" use is either partially or not supported in the North Branch depending upon the location. The South Branch is considered to have a degraded fish community because of pollution sources and habitat destruction and a severely impaired macroinvertebrate community; hence, the river will not support the "aquatic life" designated use. Chlordane and PCB contamination of fish tissue has been detected in the past; hence, the South Branch Pennsauken along with the mainstem fails to support the “fish consumption use.”

5.3.3 Rancocas Creek

Bacterial monitoring indicates that the McDonalds Branch, the North Branch Rancocas at Pemberton, and the South Branch Rancocas at Vincentown all fully support primary contact (swimming) recreation. The other areas (i.e., stations) don’t fully support to

varying degrees. Macroinvertebrate assessments indicate that the upper portions of the North Branch Rancocas fully support the "aquatic life support" designated use. The lower reach of the North Branch, along with some of the North Branch tributaries, only partially supports the use. The South Branch also largely partially supports the use; however, significant portions do not support the use. Full support is limited within the South Branch watershed.